KUALA LUMPUR INTERNATIONAL AIRPORT

Bird Strike Study

ANNEX I5
BIRDSTRIKE HAZARD

CONTENTS

GLOSSARY OF TERMS

Resident	The ornithological term used to refer to a species which lives and breeds in one area.
Migrant	The ornithological term used to refer to a species which breeds in one area, but moves to another for a period of time (usually to escape climatic changes).
Passage	The ornithological term meaning on-the-move. A bird is on passage during the time it leaves its breeding grounds and its arrival at its wintering ground. This period varies between species and can be for several months.
Roost	The orniothological term used to refer to a congregation of birds in a flock at a resting place.
Wintering	The ornithological term for the period of time a migrant bird spends in the tropics. Its spends its "winter" in the tropics.
Raptor	The term used for all diurnal birds of prey, Family : Accipitridae.
Shorebird	The term used for birds of the Family : Charadriidae
Autumn Migration	The southward movement of northern breeding birds to the tropics to escape the winter. (mid-September to late-November).
Spring Migration	The northward movement of these same birds, returning to their breeding grounds. (mid-March to late-April).

LIST OF ACRONYMS

DCA	Department of Civil Aviation, Malaysia
AWB	Asian Wetland Bureau
KLIA	Kuala Lumpur International Airport, Sepang
NOTAM	Notice to Airmen
AIS	Aeronautical Information System
DVOR	Doppler VOR
DME	Distance Measuring Equipment
VJR	Virgin Jungle Reserve

SUMMARY OF RECOMMENDATIONS

- The migratory bird route patterns over an area of radius 25 km from the KLIA should be mapped. This study should cover both "legs" of the migration, the southward or autumn migration and the northward or spring migration. Major routes affecting flight paths should be marked on pilotage charts.

- The alignment of all the four runways should be along the proposed northwest - southeast direction. The alignment of the fourth runway perpendicular to the other three is not advisable.

- During the planning and construction of the airsite, attention must be paid to the recommendations for modification of the habitat. This will ensure the existence of conditions at the airsite least likely to attract birds.

- Bird-proofing of airport buildings and structures is an option. It is however, recommended that bird-proofing be deferred until the airport is operational and problems are identified. Minimal cost would be incurred in this way.

- An efficient drainage system is essential to the prevention of water-logged habitats forming within the airfield. It is recommended that external drainage within the airsite be modified accordingly to prevent bird-attracting habitats from being formed.

- The disposal of rubbish and degradable waste would require efficient management. The dumping of garbage close to the airport could attract problem species.

- It is recommended that a Committee for Birdstrike Prevention is formed, comprising representatives from aviation and non-aviation agencies. This advisory body would be able to deal with issues outside the jurusdiction of the Department of Civil Aviation. This committee would also coordinate birdstrike monitoring and control activities at all airports in Malaysia. Each airport would have a Birdtsrike Control Unit, headed by a Flight Safety Officer.

- A Pilot Warning System should be devised to make available to pilots information on bird numbers and movements at any specific time.

Recommendations are also made for the usefulness of NOTAMs and AIS.

ANNEX I5

BIRDSTRIKE HAZARD

1. INTRODUCTION

Since the time when man took to the skies, he entered the domain of the birds. The aeroplane, in both past and present forms, remains a large machine with great speed but limited manueverability. Dependent on jet turbines producing enormous thrust, a fault in an engine can have disastrous consequences to an aircraft. One major source of engine problems (increased vibrations, flare-outs, shut-downs and even loss of the engine) is the ingestion of a foreign object. Increased air-intake surface areas on modern jets have increased the potential for foreign objects (e.g. birds) to be sucked in.

Birdstrike

A birdstrike is the term used to describe the event of a collision between a bird and an aircraft, almost always resulting in the death of the bird. Due to the large size of a commercial jetliner, a large area is exposed to collision with birds. The very high speeds of airborne present day jet-engined aircraft make it difficult for birds to take evasive measures.

The jet engines of an aircraft extend a cone of suction before them. Once caught within this cone, a bird has little chance of escape. Sections of an aircraft most prone to birdstrikes are the engines, the pilot's windscreen, leading edges of wings and tail, landing gear and the nose cone (radome).

Scope of this Study

This study was contracted to the Asian Wetland Bureau by Engineering & Environmental Consultants (EEC) in fulfillment of the potential bird hazard assessment section of the Environmental Impact Assessment of the proposed new Kuala Lumpur International Airport Masterplan Study at Sepang, Selangor Darul Ehsan.

Due to the nature of such a study, it would not be possible to comply with the Malaysian EIA guidelines. It was therefore decided to submit this document as a separate report. This report can be included in the Masterplan EIA as an appendix or stand on its own.

The Terms of Reference for this study are listed below.

1. Review literature and information on birdstrike hazard at Malaysian airports.

2. Examine up-to-date land-use maps of area surrounding the proposed airfield to identify different bird habitats.

3. Examine proposed layout of airfield and identify bird habitat types likely to be created.

4. Conduct ground surveys of the proposed airfield and surroundings particularly in the flight path zones.

5. Make predictions on possible birdstrike hazards to be encountered if the proposed airport is developed.

6. Make suggestions for changes in the layout and construction designs of the facilities at the proposed airport to minimize birdstrike potential.

7. Prepare guidelines for future development of surroundings (buffer zone) of airport to minimize potential hazards.

8. Make recommendations for protection of natural ecosystems near to the airport to attract/keep birds away from the airport.

9. Make recommendations for future monitoring and management of birdstrike problems at the proposed airport.

10. Prepare a report giving details of the above by 30th October 1992.

Layout of this Report

Section 1 of this report describes briefly the phenomenon of birdstrike and the context (and TOR) of this report. Section 2 describes the existing environment at the study site, evaluating the different habitat types occurring. Section 3 provides an assessment of the potential bird hazard at the proposed KLIA, identifying potential threat species, potential bird attracting habitats and an assessment of the proposed flight paths and aircraft holding points. The findings and conclusions of this study are presented in Section 4, followed by recommendations for reduction of the potential bird hazard in Section 5. A checklist of the birds recorded in the study area (and the habitats they were recorded in) during the duration of the project is attached at the end of the document.

2. DESCRIPTION OF EXISTING ENVIRONMENT

The study area was surveyed between 1st September and 31 October, 1992. Figure I5.1 shows the location of the proposed KLIA site in Malaysia. The field surveys were aimed at identifying all the different habitat types prevalent in the area. Each habitat type was then assessed in terms of their attractiveness to avifauna and the potential bird hazard that the existing bird species could pose to the KLIA.

Habitats in the area were categorized under five separate types. Each of these different habitats types are discussed separately below. A habitat map is not included in this report. Please refer to the vegetation study section of the Masterplan EIA for a map describing the various habitat types and their extent.

2.1 PEAT SWAMP FOREST

Peat swamp forest was identified as the largest area of natural vegetation in the area. Constituting the Kuala Langat South Peat Swamp Forest Reserve, this forest has been studied in the past and is listed in the Asian Wetland Directory (Scott 1989) as one of the important wetland sites in Peninsular Malaysia. This is further emphasized with the presence of a Virgin Jungle Reserve [VJR] within this forest reserve.

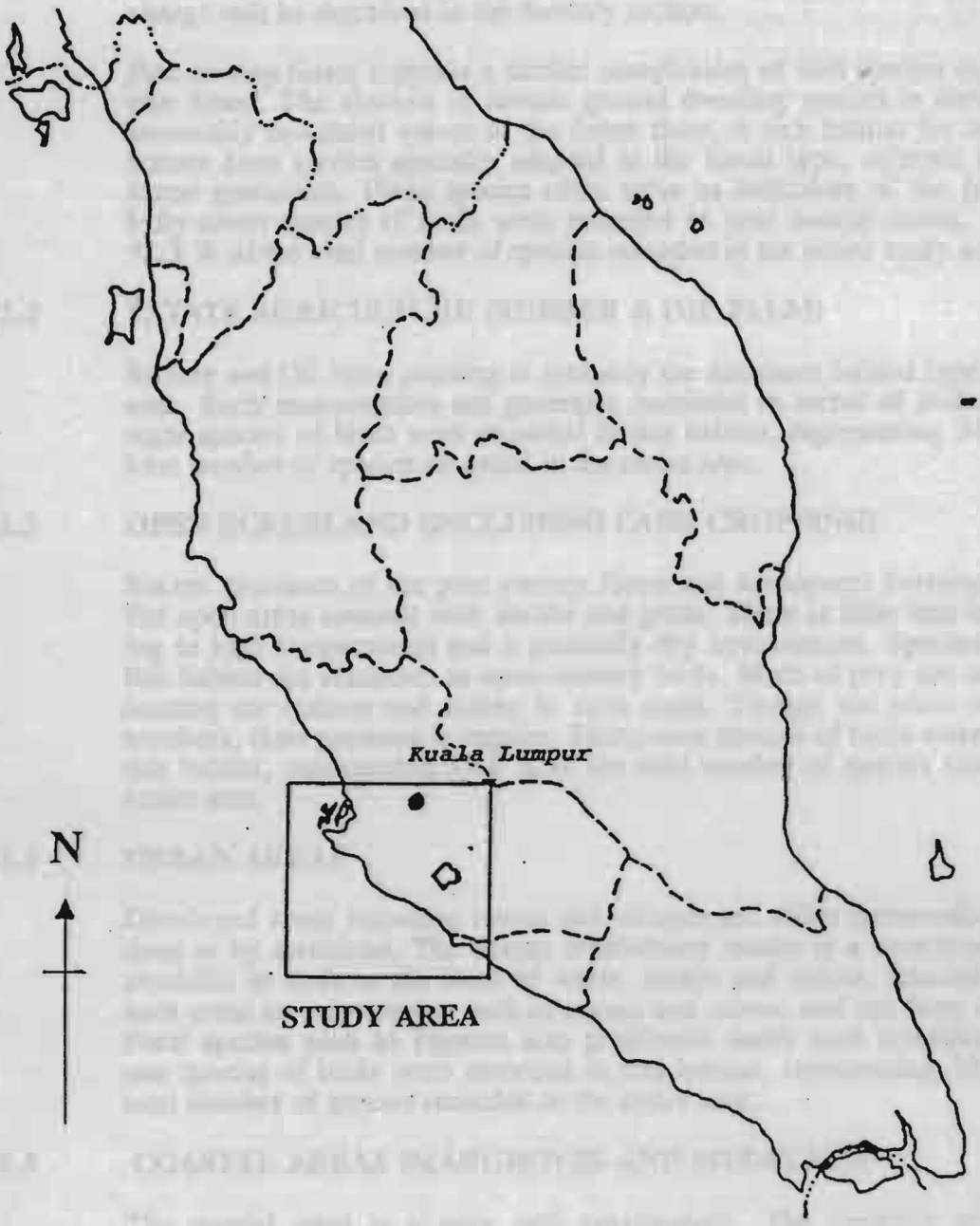


FIGURE I5.1
LOCATION OF STUDY AREA

This habitat consists primarily of forest on peat soils. Dependant on the water retention qualities of peat, the hydrology of this forest is complex and plays an important role in the overall hydrology of the area. The role of this forest in flood water storage, ground water and aquifier recharge and dry season discharge will be described in the forestry section.

Peat swamp forest supports a similar complement of bird species as the lowland rain forest. The absence of certain ground dwelling species is attributed to the seasonally inundated nature of the forest floor. A rich habitat for birds, swamp forests have species specially adapted to the forest type, referred to as swamp forest specialists. These species often serve as indicators of the forest quality. Fifty-seven species of birds were recorded in peat swamp forest, representing 52.3 % of the total number of species recorded in the entire study area.

2.2 ESTATE AGRICULTURE (RUBBER & OIL PALM)

Rubber and Oil Palm planting is probably the dominant habitat type in the study area. Such monocultures are generally restricted in terms of avifauna. Thirty-eight species of birds were recorded in this habitat, representing 34.9 % of the total number of species recorded in the entire area.

2.3 OPEN SCRUBLAND (INCLUDING CASH CROPPING)

Recent clearance of the peat swamp forest and subsequent burning has created flat open areas covered with shrubs and grass. There is little tree cover, resulting in high temperatures and a generally dry environment. Species attracted to this habitat are classified as open-country birds. Birds of prey are usually found hunting for rodents and snakes in such areas. Though not often in very large numbers, their presence is regular. Thirty-nine species of birds were recorded in this habitat, representing 35.8 % of the total number of species recorded in the entire area.

2.4 URBAN AREAS

Developed areas including towns and villages are either surrounded by plantations or by scrubland. The human inhabitation results in a source of food made available to birds in the form of waste, scraps and refuse. Species attracted to such areas are scavengers, such as mynas and crows, and can form large flocks. Feral species such as Pigeons also proliferate under such conditions. Twenty-one species of birds were recorded in this habitat, representing 19.3 % of the total number of species recorded in the entire area.

2.5 COASTAL AREAS (MANGROVES AND MUDFLATS)

The coastal zone is a very rich environment. The presence of mangroves and adjacent mudflats serves to increase the attractiveness of the area to birds. Bird species specially adapted to mangroves are restricted to them. Intertidal mudflats serve as feeding and resting areas for migratory shorebirds, known as waders. Waders congregate in very large numbers and are mostly restricted to the coast. However, certain species of shorebirds prefer freshwater areas. These species are the most probable to cause a bird hazard at the airport site itself. Forty-four species of birds were recorded in

this habitat, representing 40.4 % of the total number of species recorded in the entire area.

3. ASSESSMENT OF THE POTENTIAL BIRD HAZARD

The assessment of the potential bird hazard to aircraft using the new KLIA at Sepang was conducted by studying various features of the area. Investigations covered the areas described below.

a. An inventory of all the species of birds occurring naturally in the area, both resident and migratory was made. The hazard these species could pose to aircraft was then assessed. Potential hazard species were identified using size, flight, preferred habitat and diet. In the case of migratory species, migratory routes and roosting sites were also considered.

b. The types of habitats, both presently occurring and potentially to be created after the completion of the airport and their attractiveness to birds, especially hazard species, were identified.

c. An examination of the proposed airport layout and the existing terrain to assess the possibility of colonization by hazard species was conducted.

d. An examination of the proposed flight routes and aircraft approach altitudes was made. This is particularly important for comparison with known migratory flight routes.

e. The projected urbanization of the surrounding areas and the potential for certain bird species (though not causing a hazard at present) to become a hazard to aircraft in the future was studied.

3.1 HAZARD SPECIES

The following are the species identified within the study site threat to flying aircraft or to have the potential to pose a threat in the future. This list is in decreasing level of threat.

3.1.1 Crested Honey-Buzzard - *Pernis ptilorhynchus*

This species is both migratory and an uncommon resident in Malaysia. A medium-sized hawk, this species feeds on rodents, lizards, snakes and the larvae of honeybees (hence its name). The average weight is 750 - 800 gms. During the northern winter, this species congregates in large numbers and heads south from continental Asia to the Malay Archipelago (Medway & Wells 1976).

Largest numbers occur as they move into Peninsular Malaysia from the north. Observations on this migration over the past thirty years have shown that these birds cross the Straits of Malacca at Cape Rachado (Tanjung Tuan) in Melaka. This is the narrowest point between Peninsular Malaysia and Sumatra. This southward migration begins in mid-October, lasting

until December. Peak numbers on passage, however, have always been recorded within the first six weeks from October.

In the spring, the birds return to their breeding grounds in Asia, starting the second leg of their annual migration cycle. Honey-Buzzards on northward migration arrive at Cape Rachado during late-February to early March. This spectacular sight of these birds coming in low and then spiralling upwards has been attracting local and foreign birdwatchers to Cape Rachado for many years.

An extract from the Malayan Bird Report, 1965 on raptor migration in Selangor is included in Appendix II.
Counts of migrating Honey-Buzzards in October were done at the following places;

1. Kuala Sepang Kecil

   21/10/92 [Morning] - Number of birds counted per hour; 263, 92, 189, 144. All flocks were heading south along the coast.

2. Along Bandar Baru Salak Tinggi - Banting Road

   21/10/92 [Afternoon] - Number of birds counted per hour; 363, 293, 110, 39, 66. All flocks headed southwest, with one heading south.

3. Banting Town

   24/10/92 [Morning] - No. of birds counted per hour; 25, 43, 67. All flocks heading west, towards the coast.

4. Bangi

   24/10/92 [Afternoon] - No. of birds counted per hour; 112, 98. Two flocks heading west, six flocks heading southwest.

5. Kuala Lumpur [Jalan Cheras]

   24/10/92 [Evening] - No. of birds counted per hour; 72. Two flocks, both heading due south.

6. Kuala Selangor Nature Park, Kuala Selangor

   25/10/92 [Morning] - No. of birds counted per hour; 60, 142. All flocks heading southwards following the coast.

7. Stesen Janakuasa Sultan Salahuddin Abdul Aziz, Kapar.

   25/10/92 [Afternoon] - No. of birds counted per hour; 312, 207. Most of the birds appeared to be heading for the Klang islands, off Port Klang. The birds were rapidly lost from sight as they were flying at quite high altitudes. It is not possible to determine the actual height the birds were flying at but an estimation might be between 2000 - 3000 ft. It was also not possible to ascertain if the

birds actually flew to the islands or turned towards land further south.

Figure I5.2 shows the results of preliminary observations of the raptor migration in October 1992. This represents the southward migration. Surveys would have to be conducted in March - April to map the northward migration.

The results of these counts were inconclusive. Evidently, these birds are flying over the proposed KLIA airport site and more importantly, through the approach funnels. To undertake a full census of the raptor migration in the area, a coordinated team of observors would be required.

3.1.2 Brahminy Kite - *Haliastur indus*

This medium-sized bird (weight; 700 - 750 gms) is the most common resident bird of prey in Malaysia. In 1991, this species accounted for 16 strikes involving aircraft at Malaysian airports. On account of the weight of this bird, it makes this species the bird most likely to cause severe damage to aircraft in the country. Though found in most habitats, it is more common along the coast and feeds on fish and carrion. It therefore, poses a hazard mainly at airports along the coast. This species was not recorded at Subang in 1991 (Sebastian 1992a). Previous studies have also determined the Brahminy Kite to be attracted to airports which have shorebirds wintering at the airfield. Apart from hunting these shorebirds, these kites also feed on the carcasses of birds struck by aircraft, thus posing a direct threat to aircraft landing and taking-off.

This species was recorded in all habitats within the study area. With the new KLIA development and the imminent advent of large areas of short grass, there is a distinct possibility that this species would be attracted to the airfield.

3.1.3 Other Migrant Raptors

The migratory route taken by the Honey-Buzzards is also used by other species. Although individually they do not pose a regular and serious hazard, collectively over a short period, they could be cause for concern. The more common ones are described below.

Black Baza *Aviceda leuphotes*

This is a small raptor (weighing 250 - 300 gms) migrating in large flocks. This specie winters in small numbers in the Peninsular, using forested areas such as rubber plantations and swamp forest. This species was involved in one strike at Subang International in 1991 (Sebastian 1992a).

Japanese Sparrowhawk *Accipiter gularis*

This is a small hawk (weighing about 150-200 gms), occurring in similar numbers to Honey-Buzzards. While Honey-Buzzards fly high in loose flocks, Sparrowhawks fly lower in very dense flocks. Though individually

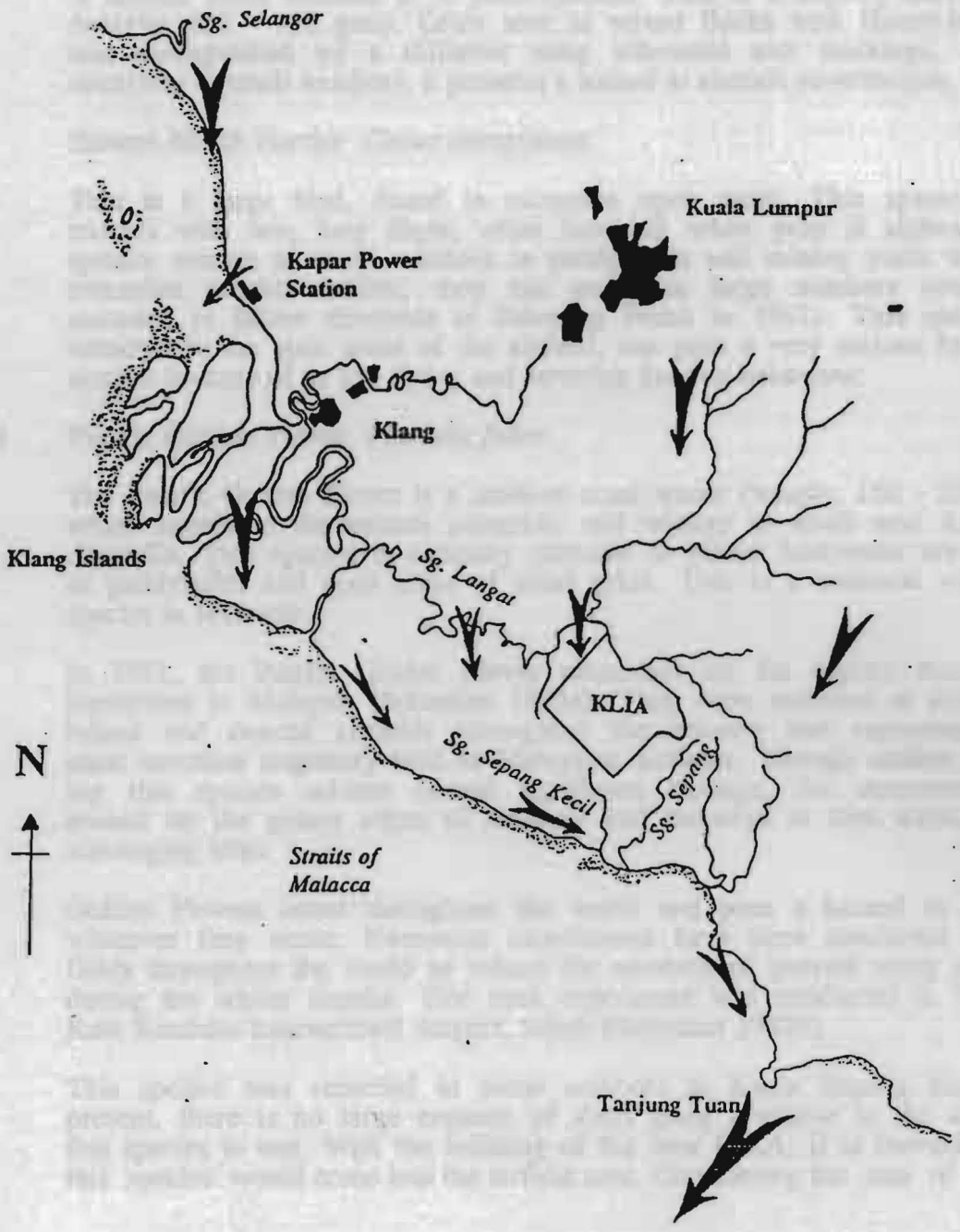


FIGURE I5.2
MIGRATION OF RAPTORS IN SOUTH SELANGOR

this species would not pose much of a threat to aircraft, an aircraft hitting a flock of Sparrowhawks could result in disastrous consequences.

Chinese Goshawk *Accipiter soloensis*

Another small hawk, only slightly larger than the above species. Occurs in much smaller numbers, often in mixed flocks with preceeding species.

Grey-faced Buzzard *Butaster indicus*

A similar sized buzzard to *P. ptilorhynchus*. This is a slightly heavier bird (weight; 650 - 750 gms). Often seen in mixed flocks with Honey-buzzards and distinguished by a different wing silhouette and markings. Though occurring in small numbers, it presents a hazard to aircraft nevertheless.

Eastern Marsh Harrier *Circus aeroginosus*

This is a large bird, found in extensive open areas. This species hunts rodents with low, lazy flight, often hovering when prey is sighted. This species winters in small numbers in paddyfields and mining pools but with extensive suitable habitat, they can occur in large numbers (over 100 recorded in fallow ricefields in Seberang Perak in 1991). This species, if attracted to the open areas of the airfield, can pose a very serious hazard to aircraft because of its low flying and hovering hunting behaviour.

3.1.4 Pacific Golden Plover *Pluvialis fulva*

The Pacific Golden Plover is a medium-sized wader (weight; 150 - 200 gms) which breeds in the eastern palearctic and winters in south east Asia and Australia. This species is naturally attracted to inland freshwater areas such as paddyfields and open areas of short grass. This is a common wintering species in Malaysia.

In 1991, the Pacific Golden Plover accounted for the highest number of birdstrikes in Malaysia (Sebastian 1992a). They were recorded at almost all inland and coastal airfields throughout the country and represented the most common migratory bird at Malaysian airfields. Though strikes involving this species seldom caused significant damage, the carcasses lying around on the grassy edges of runways and taxiways in turn attracted the scavenging kites.

Golden Plovers occur throughout the world and pose a hazard to aircraft wherever they occur. Numerous experiments have been conducted at airfields throughout the world to reduce the numbers of plovers using airfields during the winter months. One such experiment was conducted in 1991 at Kota Kinabalu International Airport, Sabah (Sebastian 1992b).

This species was recorded in some numbers at Kuala Sepang Kecil. At present, there is no large expanse of short grass available in the area for this species to use. With the building of the new KLIA, it is inevitable that this species would come into the airfield area. Considering the size of the

proposed airport area and the extended open area due to the eventual construction of four runways, this species could pose a serious problem.

Figure I5.3 shows the areas along the coast of south Selangor which has high shorebird and seabird activity during the period from September to April. Although most of the species would not come to the airfield, the daily movements of these birds along the coast could pose a hazard to low-flying aircraft.

3.1.5 Common Myna *Acridotheres tristis*

This bird is one of the most common birds around human habitation. The Common Myna is bold and habituated to man. Attracted to refuse and garbage, this species can achieve very large populations within short periods of time. Mynas nest under roofs in buildings and form large roosts at night. The characteristic incessant chattering easily identifies these roosting areas, usually on trees in car parks and along roads.

If in very large numbers, this species could cause a hazard to aircraft, though figures from 1991 show a comparatively low strike rate involving this species (Sebastian 1992a).

3.1.6 Cattle Egret *Bubulcus ibis*

The Cattle Egret is a migrant long-legged white bird (approximate weight; 280 - 350 gm.), found in ricefields and associated with cattle. Occurring in large numbers in open fields, this birds can pose a hazard to aircraft at the airport itself. One known wintering site for this species is the grazing fields in the campus of Univeristy Pertanian Malaysia at Serdang, north of the study area. With similiar open fields to be created at KLIA, there is the possibility of this species using the airport.

3.1.7 Snipes *Gallinago* spp. .

Three species of snipe spend the winter in Malaysia. These birds are secretive, spending the day hidden in long grass and becoming active at night. Snipes are often hunted for food. Approximate weight; 200 gm.

All strikes involving snipes in 1991 occurred at night (Sebastian 1992a). This species would definitely occur at the airfield.

3.1.8 Oriental Pratincole *Glareola maldivarum*

This bird is a swallow-like wader which, in Malaysia, breeds only in the north, and migrates southwards in October. Though this species does not winter in any significant numbers in Malaysia, it passes through in large numbers. On passage, they tend to spend short periods of time at airfields before moving on. During this time, pratincoles can pose a serious bird hazard, mainly due to their behaviour of dense flocking and hovering over heated tarmac. This species has been involved in strikes at Subang International in 1991.

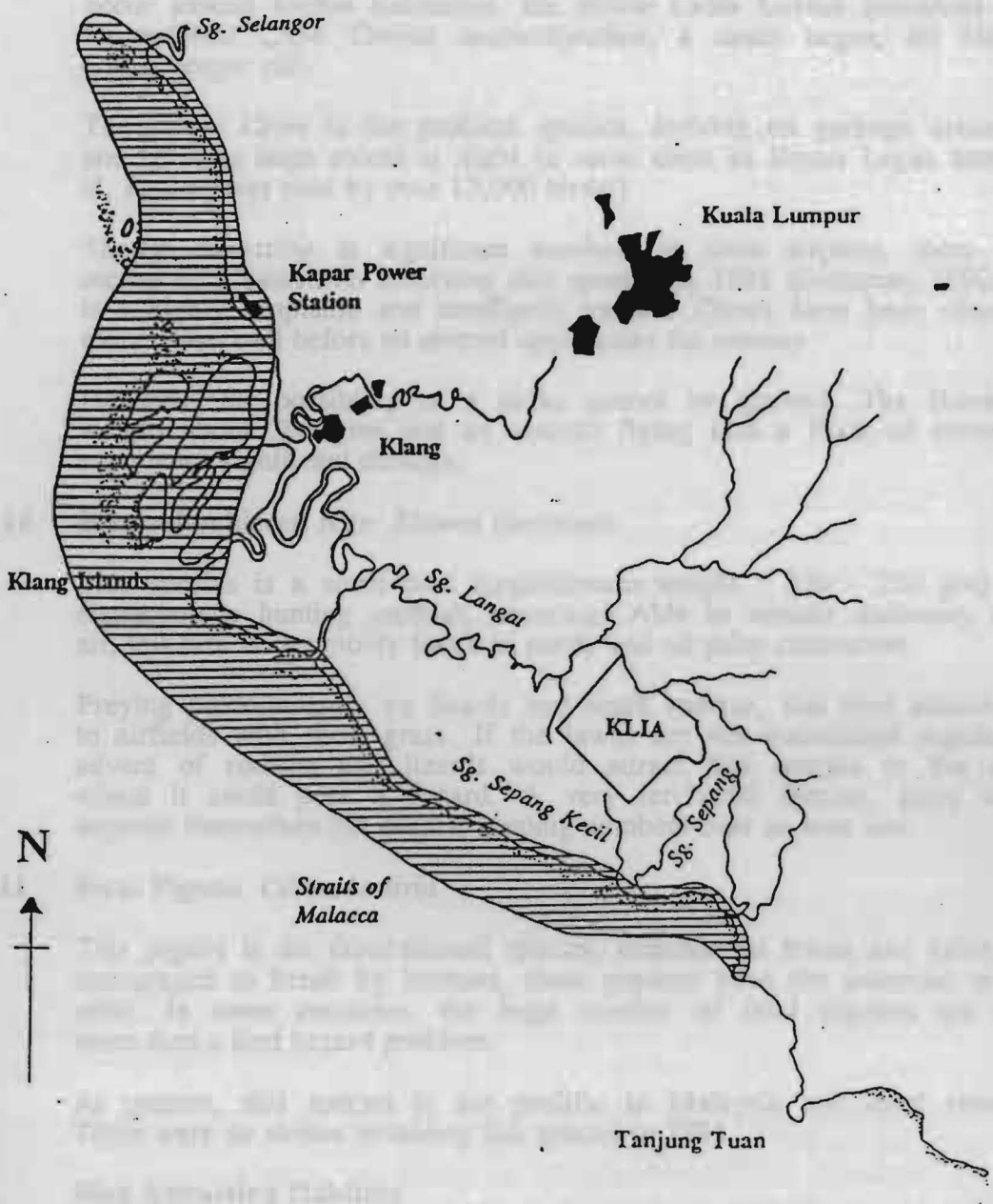


FIGURE I5.3
AREAS USED BY SHOREBIRDS ALONG THE SELANGOR COAST

Pratincoles were not recorded within the study area. However, they must pass through on migration and would definitely appear at the airfields for short periods (3 -4 days) in October and March every year.

3.1.9 Crows *Corvus* spp.

Recent efforts to control the number of crows in certain parts of the country have made little impact on the overall population. Two species of crows occur around human habitation, the House Crow *Corvus splendens* and the Large-billed Crow *Corvus macrorhynchos*, a much larger, all black bird with a deeper call.

The House Crow is the problem species, thriving on garbage around cities and forming huge roosts at night (a roost close to Bayan Lepas International, Penang was used by over 13,000 birds!)

Though occurring in significant numbers at some airports, there was no record of a birdstrike involving this species in 1991 (Sebastian 1992a). This is a highly adaptable and intelligent species. Crows have been observed to move away well before an aircraft approaches the runway.

However, the possibility of a strike cannot be ignored. The House Crow weighs about 300 gms and an aircraft flying into a flock of crows could experience significant damage.

3.1.10 Black-shouldered Kite *Elanus caeruleus*

This species is a small bird (approximate weight : 230 - 250 gm) with a characteristic hunting method; hovering. Able to remain stationary in mid-air, this bird is commonly found in paddy and oil palm cultivation.

Preying predominantly on lizards and small rodents, this bird seldom comes to airfields with short grass. If the lawns are not maintained regularly, the advent of rodents and lizards would attract this species to the airfields where it could pose a hazard. A very territorial species, pairs naturally separate themselves out evenly, keeping numbers over an area low.

3.1.11 Feral Pigeon *Columba livia*

This pigeon is the domesticated species, common in towns and cities. Often encouraged to breed by humans, these pigeons have the potential to proliferate. In some countries, the huge number of feral pigeons are causing more than a bird hazard problem.

At present, this species is not prolific in Malaysia and must remain so. There were no strikes involving this species in 1991.

3.2 Bird Attracting Habitats

The entire area of Sepang district was surveyed for ideal bird habitats, with emphasis on the presence of potential hazard species. The two existing habitats identified as the richest in avifauna were the Peat Swamp Forest

with 52.3 % of the birds recorded during the entire study and the coastal habitat, with 40.4 %.

3.2.1 Peat Swamp Forest

In terms of bird species, this is obviously the richest habitat. However, in terms of bird hazard, it is the number of hazard species that is relevant. Most of the birds occurring in a peat swamp forest are restricted to the forest and seldom leave the understorey or canopy, thus not posing a threat to aircraft. In general, it is the open-country species that pose the greatest hazard.

Large open-country species on migration, such as raptors, will occassionally use tracts of natural forest / vegetation to rest and feed.

3.2.2 Coastal Habitat

The coast is always a rich habitat for birds, especially with the presence of intact mangrove forest and intertidal mudflats. Migratory shorebirds feed on the exposed mudflats at low tides and congregate in certain areas when pushed off the mudflats by the rising tide. These areas are called "high-tide roosts" and play an important role in the continued survival of these shore-birds. In areas where such sites do not exist these birds are forced to fly long distances to rest until the tide recedes.

Airports provide an ideal roosting site for these birds and in some cases, e.g. Subang International, the birds do not leave and spend the entire winter at the airfield.

3.2.3 Waterlogged & Swampy Areas

The terrain on the western side of the proposed KLIA site is a flat peaty basin. The peat soils of this area have high water absorption capabilities. Extensive drainage and excavation of the peat (to be replaced with laterite soils) would result in the low basin becoming prone to flooding after heavy downpours. Without efficient drainage, waterlogging would result with the creation of grassy swamp areas.

Any expanse of a flat waterlogged environment, with or without herbaceous cover, would attract birds. Dense vegetation would attract bitterns, rails, snipes and crakes. Bare ground or short grass would make ideal shorebird habitat.

3.3 Approach Funnels

As the density of birdlife decreases with increasing altitude, an aircraft is subjected to a greater bird hazard the lower it is. Thus, the most obvious areas where birds are likely to hit aircraft are the approach and take-off corridors. As a corollary, the risk of birdstrike increases as the aircraft gets closer to the runway.

A minimum altitude of 1800 metres a.g.l. is the standard International Civil Aviation Organization (ICAO) recommended height at which aircraft are

considered safe from birdstrikes. This height can be reached rapidly on take-off to minimize the time spent by the aircraft below this height.

The present plan to align a fourth runway at right-angles to the other three would double the "Approach Funnel" area of KLIA. The practicality of doubling the area where intensive bird control must be implemented must be weighed against the advantages of a fourth runway with a different alignment. See Figure I5.4.

3.4 Inbound-Outbound Routings

Section D4.3.8 of the Draft Final Report proposes two new DVOR/DME in the areas of Pulau Carey (VPC) and Port Dickson (VDX). The two areas chosen are the two sites in Peninsular Malaysia with the highest known migratory bird activity.

3.4.1 Pulau Carey (VPC)

The Klang Islands consist of five large islands forming the estuary of the Sungei Klang; Pulau Carey, Pulau Lumut, Pulau Klang, Pulau Ketam and Pulau Tengah. Pulau Carey was converted to Oil Palm planting in the 70's and Pulau Lumut is currently undergoing conversion into a golf course. Pulau Ketam has two fishing villages. The remainder of the islands constitute a mangrove forest reserve. There are extensive mudflats on the western side of the islands and the largest shorebird site in Malaysia is located at the southern tip of Pulau Tengah.

During the periods of southward (late-August to early-November) and northward migration (early-March to late-April), large numbers of shorebirds move along the coast and across the Straits with high densities over the Klang Islands. It is unknown at what heights these birds regularly fly while on migration but birds flying above 1000 m is normal and records up to 6000 m are not unknown for long-distance migrant shorebirds.

Data on what heights aircraft would be at VPC is not available. During the periods mentioned above, aircraft at low altitudes at VPC would be exposed to large and potentially dangerous flocks of shorebirds. (See Figures D4.1 & D4.2, Draft Final Report, Vol D.)

3.4.2 Port Dickson (VDX)

The other holding point at Port Dickson is, coincidentally, at another important migratory corridor in Malaysia. Cape Rachado (Tanjung Tuan) has historically been the congregating point for migratory raptors (birds of prey) crossing the Straits of Malacca to Sumatra. All birds of prey soar on thermals, becoming more active after 1000 hrs. Larger species can soar up to 2000 m with little effort.

The sheer number of medium to large sized birds using this route makes this point very hazardous to low flying aircraft. Raptor migration begins

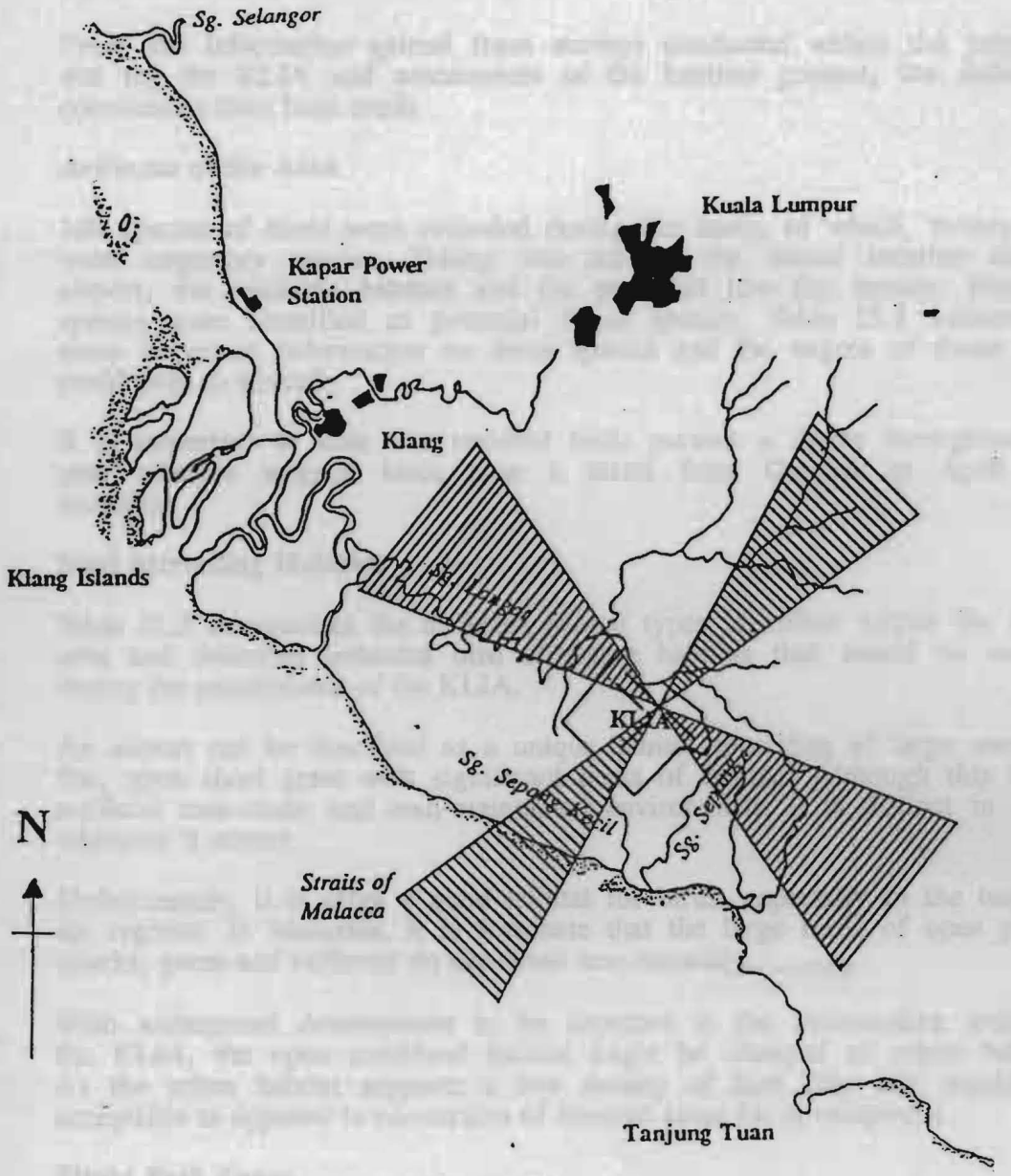


FIGURE I5.4
HIGH RISK AREAS TO AIRCRAFT
(APPROACH FUNNELS)

in mid-October, continuing with decreasing intensity till mid-December. The return leg begins in late-February and continues till late-April.

Though fewer in number (compared to shorebirds), raptors are much larger and a single bird is capable of causing serious damage to an engine. The raptor migration poses a further danger by being sustained over longer periods. (See Figures D4.1, D4.2 & D4.3, Draft Final Report, Vol D.)

4. FINDINGS AND CONCLUSIONS

From the information gained from surveys conducted within the proposed site for the KLIA and assessments of the habitats present, the following conclusions have been made.

4.1 Avifauna of the Area

109 species of birds were recorded during the study, of which, twenty-nine were migratory species. Taking into account the inland location of the airport, the available habitats and the prevalent low flat terrain. Eighteen species were identified as potential threat species. Table I5.1 summarizes some important information on these species and the degree of threat they could pose to aircraft.

It is important to note that resident birds present a threat throughout the year whereas migrant birds pose a threat from October to April (six months).

4.2 Bird Attracting Habitats

Table I5.2 summarizes the different habitat types identified within the study area and describes potential bird attracting habitats that would be created during the construction of the KLIA.

An airport can be described as a unique habitat consisting of large areas of flat, open short grass with significant areas of tarmac. Although this is an artificial man-made and man-maintained environment, it is distinct in itself wherever it occurs.

Unfortunately, it is often a good habitat for birds, especially in the temperate regions. In Malaysia, it is fortunate that the large birds of open plains (ducks, geese and vultures) do not occur here naturally.

With widespread development to be expected in the surrounding areas of the KLIA, the open scrubland habitat might be changed to urban habitat. As the urban habitat supports a low density of bird life, this would the acceptable as opposed to conversion of forested areas for development.

4.3 Flight Path Zones

It is the finding of this study that the currently proposed approach routes and DVOR holding points were inadvertently selected to coincide closely with migratory bird movements in the area. The conclusions of this study are;

TABLE 1 - BIRD SPECIES WITH THE POTENTIAL TO POSE A HAZARD TO AIRCRAFT AT KLIA

SPECIES	LOCAL NAME	STATUS	WT.	HABITAT	DIET	THREAT
Crested Honey-Buzzard	Helang Madu	Migrant	800g	open area	carnivore	High
Black-shouldered Kite	Helang Tikus	Resident	240g	open area	carnivore	Low
Brahminy Kite	Helang Merah	Resident	700g	open area	carnivore	High
Black Baza	Helang Hitam	Migrant	210g	forest/rubber	carnivore	Potential
Japanese Sparrowhawk	Helang Kecil Jepun	Migrant	140g	open area	carnivore	Potential
Golden Plover	Rapang Kerinyut	Migrant	150g	open area	insectivore	High
Common Snipe	Berkek Berbintik	Migrant	150g	open area	insectivore	Medium
Barn Swallow	Sualo Api	Migrant	15g	open area	insectivore	Low
House Crow	Gagak Rumah	Resident	400g	urban	omnivore	Low
Large-billed Crow	Gagak Paruh Besar	Resident	530g	sub-urban	omnivore	Potential
Philippine Glossy Starling	Perling Mata Merah	Resident	32g	urban	grammivore	Low
Common Myna	Tiong Gembala Kerbau	Resident	105g	urban	omnivore	Medium
Jungle Myna	Tiong Hutan	Resident	87g	sub-urban	insectivore	Low
Feral Pigeon	Merpati	Resident	280g	urban	grammivore	Potential
Spotted Dove	Tekukur	Resident	100g	open area	grammivore	Low
Peaceful Dove	Merbok Aman	Resident	50g	open area	grammivore	Low
Long-tailed Parakeet	Bayan Nuri	Resident	40g	plantation	frugivore	Potential
Cattle Egret	Bangau Kendi	Migrant	280g	open area	insectivore	Potential

TABLE 2 - EXISTING & POTENTIAL HABITAT TYPES WITHIN THE STUDY AREA

HABITAT TYPE	NO. OF SPECIES RECORDED	STATUS		ATTRACTIVENESS TO POTENTIAL PROBLEM BIRDS	LEVEL OF THREAT TO AIRCRAFT
Peat Swamp Forest	57	Within Airport	Existing	Medium	Medium
		Surroundings	Existing	Low	Low
Rubber & Oil Palm Estates	38	Within Airport	Existing	Low	Low
		Surroundings	Existing	Low	Low
Open Scrubland (including Cash Cropping)	39	Within Airport	Existing	Medium	High
		Surroundings	Existing	Medium	Low
Urban Areas	21	Surroundings	Existing	Low	Low
Coastal Areas (Mangroves & Mudflats)	44	Surroundings	Existing	High	Low
Open Grassland (with large area of Tarmac)	?	Within Airport	Potential	High	High
Open Wet/Swampy Areas with Low Vegetation	?	Within Airport	Potential	High	High
		Surroundings	Potential	High	Medium

a. Holding Point VPC is at an area of intense migratory bird (shorebirds) activity. As aircraft heights (a.g.l.) at this point is not available, it is not possible to ascertain the bird hazard. It would, however, be possible to say that aircraft below 1000 m would be exposed to a significant level of bird hazard.

b. Holding Point VDX is also at an area of high migratory bird activity. The bird hazard at this point would be very much more serious as much larger and heavier birds (raptors) are at this point. Aircraft at this point below 2000 m would be exposed to a significant level of bird hazard.

c. The northeast - southwest alignment of the fourth runway results in a 50% increase in approach funnel area if the runway is used only for either take-offs or landings in one direction. If it is used for both landings and take-offs in both directions, the approach funnel area would be increased 100%. This is also directly related to air-traffic volume. Refer Figure I5.3.

d. The proposed 10,000 ha site for the KLIA is 30 km north of Cape Rachado, the main crossing point for migratory raptors on the Straits of Malacca (Refer Figure I5.1). High densities of birds are expected to be flying over the airport area during the period between October and March every year. Though seasonal, during this period there could be a serious bird hazard at KLIA.

The large areas of tarmac at the airport (runways, taxiways & aprons) are unavoidable and would create thermals (columns of heated air) when heated. These thermals would inevitably attract raptors and further increase the hazard.

5. RECOMMENDATIONS

Based on the conclusions from the study, the following recommendations are made to reduce to a minimum the potential bird hazard at the Kuala Lumpur International Airport, Sepang.

5.1 MIGRATORY RAPTOR ROUTES

The migration of raptors over the proposed KLIA site poses the highest bird hazard. In order to be able to recommend mitigation measures, the precise routes taken by these raptors must be mapped out. It is recommended that a study be conducted to map out these routes, using synchronized surveys throughout the Sepang area. The information gathered from this study would help plan the safest flight-paths and approach routes during the migratory periods. The study should be repeated to ascertain whether the routes change from year to year. Weather conditions could play an important part in the choice of the flight routes of the raptors.

It is also recommended that bird migratory routes and the times of year they are used should be put onto pilotage and landing charts on board aircraft. This allows pilots arriving at a Malaysian airport for the first time

to be immediately aware of migratory routes in the area and where they cross his flight path.

5.2 RUNWAY ALIGNMENT

The primary concern at KLIA should be to reduce to a minimum the period during which an aircraft is exposed to birds. This can effectively be achieved by reduction of flight airspace, i.e. the areas along which aircraft are flying below 2000 m.

The current proposed alignment of the fourth runway, perpendicular to the other three, increases this "danger zone" by 50 % (take-offs only) and 100 % (landings and take-offs).

It is therefore recommended that all four runways be aligned along the same direction, maintaining the presently proposed northwest - southeast alignment. This will restrict the approach funnels to two, used by all four runways.

5.3 HABITAT MODIFICATION

As it is not possible to exclude birds from an area without a physical barrier, the alternative would be to modify the area to one that the birds would not come to. The following are some reasons why birds use a habitat and some ideas on how to modify that habitat.

5.3.1 Food Source

One of the most important reasons for the presence of birds in an area is a source of food. Therefore, the airport premises must be devoid of any natural source of food to birds. Kitchen scraps and other edible garbage attracts scavenging birds. This also includes fruiting plants and trees (fruit-eating birds), seeding plants (seed-eating birds), stagnant pools and swampy areas (insects, crustaceans, rodents, lizards & snakes).

This requires selective tree planting and control over which species of grass is to eventually cover the entire airsite. Grass species with prolific seeding stages would attract birds during these periods and should be avoided.

5.3.2 Cover/Shelter

Although birds would generally feed where there is food, they also require shelter. This is normally in the form of vegetation, either long grass, thick bushes and thickets or tree foliage. Large areas of natural cover with sufficient food within it would, in principal, keep birds within this area. Two such areas with an open space between them, a runway for example, would result in birds crossing the runway from one patch to the other.

Therefore, it is recommended that small areas of thick vegetation (and all areas of long grass) be removed. However, large areas of natural vegetation is advantageous provided it is not fragmented.

5.3.3 Grass Planting

It is important to have a grass species on the airsite which can be easily managed. The ideal species would be a grass which does not naturally grow very tall and can be maintained at a specified height when required. This is to allow for the use of a bird control technique for Plovers which involves keeping grass heights at six inches for the period between October and March (Sebastian 1992b).

It is commonly agreed that the grass species *Cynodon dactylon*, known by a variety of names including Couch Grass, Bermuda Grass, Dhub Grass is a suitable species for airfield lawns (Ali & Grubh 1989). It is easy to maintain and has good soil binding qualities. The ability to maintain this species at even heights of at least six inches must be investigated before it is recommended.

5.4 BIRD PROOFING OF BUILDINGS AND STRUCTURES

Most birds require a raised or protruding object to perch on. If removal of these birds is not possible, the next step would be to deny the birds access to these perches. Removal of all such "perches" would prevent these species from resting, resulting in their moving away from the area.

In view of the problem species identified at the proposed KLIA, this practise would not keep away most of these species, mainly due to the fact that these birds are not perching species. It would, however, exclude species such as Barn Swallows *Hirundo rustica*, a very common migrant which winter in large numbers at some Malaysian airports. It is also in the interest of general safety and cleanliness to prevent birds breeding in airport buildings.

Note : These recommendations may be deferred until the airfield is operational and the actual problem are identified. Minimal expenditure will be required for their implementation if the need is felt.

5.4.1 Airport Buildings

Building plans should be designed to include modifications to all exterior ledges, window sills, open eaves, roof gutters and open ventilation gaps or holes. These places are used by smaller birds such as Sparrows *Passer montanus* and Common Mynas *Acridotheres tristis* to breed. Ledges and sills are used as perching areas and gaps are used for nesting. Ventilation holes and roof eaves can be closed with the use of mesh, preferably of a material that would not have to be changed too often (wire mesh tends to rust).

Hangars and other large-roofed buildings can be pigeon proofed with a similiar mesh, laid as an extra ceiling below the roof struts and supporting beams.

5.4.2 Airport Structures

All structures on the airsite (antennae, ILS, radar, approach lights, runway lights) provide perching sites for birds. It is recommended that all perma-

nent structures on the airsite be fitted with anti-perching spikes. These are thin metal spikes attached to all surfaces which prevents birds from perching on them. In the case of runway edge lights, a single spike in the top would make it very difficult for a bird to sit on it.

The ideal situation would be such that once a bird flew over the perimeter fence, it would find no where to sit and would have to fly out of the airport premises to rest.

5.5 DRAINAGE

Proper drainage is very important to prevent the formation of waterlogged areas. The terrain must be smooth, with appropriate gradients to achieve efficient drainage. Extensive earthworks are proposed to replace 18 million cubic metres of peat soil with 25 million cubic metres of laterite. It is crucial that sufficient settling time is allowed to prevent sinking in the future. Even slight sinking (not effecting runways or structures) would cause waterlogging during heavy rains and creation of bird habitats. Swampy areas also prevents efficient cutting of grass and leads to a decline in the appearence of the airsite.

Open drainage within the airsite should have vertical concrete sides with the concrete extending a minimum distance of 0.5 m from the top of the drain. This is to prevent vegetation from growing along the sides of drains which provides ideal habitat for birds (Sebastian 1992a). All drains should also be regularly cleaned.

5.6 RUBBISH DISPOSAL

The inevitable rubbish and degradable trash from the airport and its surrounding facilities would have to be effectively managed. Casual disposal of waste food in the vicinity would attract scavenging birds.

The main problem would be control of trash disposal outside the airport. A rubbish dump close to the airport perimeter would cause an increase in the number of birds in that area and could result in a bird hazard.

The cleanliness of the airsite is also important. Regular inspections of the runways, taxiways & aprons should be conducted to collect carcasses. Birds hit by aircraft and left lying on the airfield attract scavenging birds.

5.7 BIRDSTRIKE PREVENTION COMMITTEE

In order to address the bird hazard problem at KLIA and at all Malaysian airports, it is recommended that a committee be set up to coordinate all the related activities. The Birdstrike Prevention Committee would serve as an advisory monitoring body, with representatives from all relevant departments and institutions on the board. This committee would be able to address problems, particularly those in the areas outside the actual airport premises where agencies, not under the jurusdiction of the Department of Civil Aviation, are involved.

The implementation of bird control measures within the airport should

come under an Flight Safety Officer at KLIA. He would be responsible for a bird hazard prevention programme for the airport. This officer would be responsible for the tasks listed below.

a. The compilation of all birdstrike reports from pilots and other sources for KLIA. Secondary data should also be recorded from the maintenance engineers (evidence of birdstrikes from aircraft fuselage or within engine parts during regular aircraft maintenance). The main obstacle in birdstrike studies is the inconsistency of the data. More often than not, the information on a birdstrike is incomplete. In order to be able to quantify the problem and identify the species actually being hit, a database would have to be maintained, recording all incidences of birdstrike in the country and ensuring that all incidences are reported. Sources of birdstrike information include the pilot, runway inspection officers, ATC and maintenance crews.

b. The establishment of a system for the collection of birdstrike remnants (carcasses) from the runways and taxiways. These remains should be promptly sent to experts for species identification. A specimen collection facility should also be set up to maintain a reference databank on bird remains and their feathers. From this databank, any species of bird involved in a strike could be identified from a single feather.

c. The design, planning and enforcement of birdstrike prevention measures. These measures would cover two specific areas; within the airport and outside the airport.

Within the Airport

This requires a combined and coordinated effort from the various departments and agencies operating at the airport. The tasks of major importance are listed below.

Prevention of waterlogging and maintenance of effective drainage

The Sepang area is subject to significant levels of rain throughout the year. As the airfield is to be built, to a large extent, on peat soils, complete levelling and grading of the area may not be achieved within the first year of operation. Even after best possible conditions are achieved in terms of hardness and smoothness of the airfield surface area and a good gradient for rapid drainage, maintenance activity cannot be neglected. This is because the land is liable to change its consistency at localized areas through interaction of biotic and abiotic factors such as soil organisms, vegetation and water. This will result in loosening of the soils and formation of microhabitats attractive to birds, directly or indirectly.

Maintenance of Airfield Vegetation

No vegetation other than grass should be permitted to grow within the airiste. The grass should be maintained as short as possible. The adjustability of the height of the grass is important in implementing certain bird control measures. The species of grass to be used should be researched thoroughly.

Cynodon daclylon is commonly used due to its many qualities. It is the duty of the maintenance staff to maintain the lawns through regular mowing.

Bird-proofing of Airport Buildings & Other Structures

Although bird-proofing would have been effectively carried out at the first instance, continuous monitoring and maintenance is essential.

Birdstrike Control Unit

There should be a full-time birdstrike control unit in constant contact with the ATC. The ideal vehicle for this would be the "Safety One" vehicle. This unit would carry out regular checks of the entire airsite (runways in particular) for birds. Information on number of birds, location and movements of flocks could be either communicated to ATC or to aircraft directly. They would also be responsible for the removal of dead birds.

This unit would also be responsible for the use and maintenance of bird-scaring devices within the airfield.

Outside the Airport

While implementation of bird control measures within the airport is an internal affair, this is not so outside the boundaries of the airport. This Committee, with representatives from government departments and private sector agencies on the board, will have legal jurusdiction to influence the development policies affecting the areas outside the airport but immediately adjacent. This is important to avoid a bird hazard developing from a source outside the airport, over which the airport would have no control over.

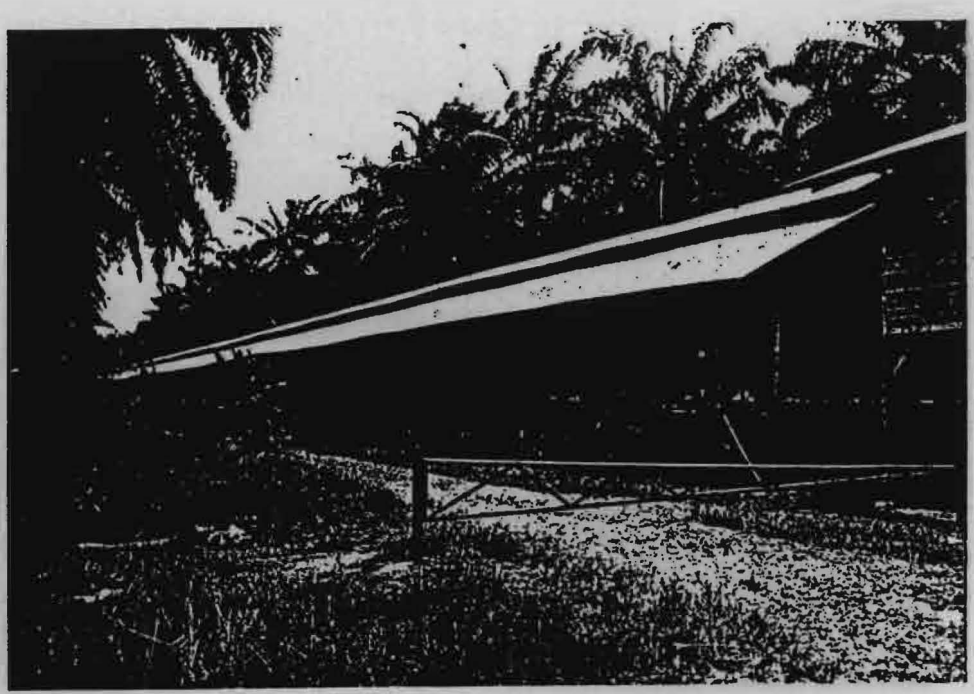
It is also in the interest of general public safety that the development of areas surrounding the airport be managed effectively.

5.8 PILOT WARNING SYSTEM

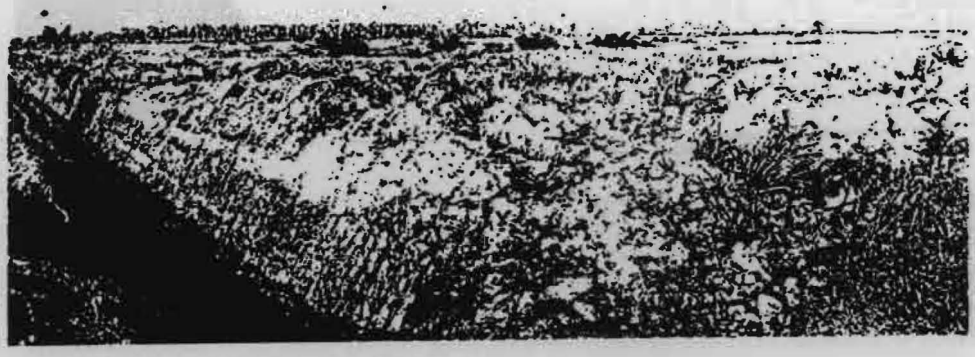
It is strongly recommended that information on bird numbers and movements be made available to pilots using the airspace. A warning system should be devised allowing a pilot on an approach run to be warned if there is a high level of bird activity at the airfield. Although such information is often considered momentary, it does have the advantage of preparing the pilot in case of an emergency.

The existing NOTAM and AIS systems should be used more extensively. It is also very important to constantly update NOTAMs to avoid old information remaining in circulation. This is especially relevant given the seasonal peaks in bird hazard identified in this study.

Peat Swamp Forest with cash-cropping in foreground



Poultry Farm within an Oil Palm Estate



Open Scrubland north-west of KLIA

Open Scrubland within proposed KLIA site

Coastal Habitat, sandy beaches with mudflats beyond

Coastal Habitat - Mangroves at mouth of Sg. Sepang Kecil

Typical airsite habitat - short grass & tarmac

Shorebirds (Golden Plovers) on airport runway

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APPENDIX II

RAPTOR MIGRATION IN SELANGOR

Following the observations of large-scale movements of raptors through the lowlands of Selangor in 1963 (see 1963 report), a detailed study was made of migration of hawks during spring and autumn 1964.

Summary of Findings during 1964

1. The 1964 observations again recorded autumn movcements through the Selangor lowlands in a size and scale similiar to those of 1963.

2. They also repeat the observation that the main concentration of Honey-Buzzards on migration is within 10 miles of the coast (more concentrated in 1964 than in 1963), and suggest that few migrating hawks follow routes as far east as the main range.

3. On available evidence, Sparrowhawks seem to migrate on a broader front than Honey-Buzzards.

4. Spring migrations in Selangor are less conspicious than autumn migrations; this is especially true for Sparrowhawks.

5. Cape Rachado is a major landfall for Honey-Buzzards in the Spring (and is, incidently, an unrivalled place for seeing them flying low in large numbers). More observations are needed to find out whether the numbers seen in 1964 are typical.

6. Large migrations have been seen near the coast as far north as Perak. Southwards, it is not clear how many birds reach Singapore.

The above information is extracted from the Malayan Bird Report, 1965. This report was published in the Malayan Nature Journal, Vol. 19., September 1965. More detailed observations and findings are described in the report and should be referred to.

Appendix III

CHECKLIST OF THE BIRD SPECIES RECORDED IN THE STUDY AREA ACCORDING TO HABITAT

NO.	SPECIES	A	B	C	D	E
1.	Little Heron *Butorides striatus*					*
2.	Crested Honey-Buzzard *Pernis ptilorhynchus*	*	*	*	*	*
3.	Black-shouldered Kite *Elanus caeruleus*		*	*		
4.	Brahminy Kite *Haliastur indus*	*	*	*	*	*
5.	Black Baza *Aviceda leuphotes*	*	*	*	*	
6.	White-bellied Sea Eagle *Haliaeetus leucogaster*					*
7.	Crested Serpent Eagle *Spilornis cheela*	*				
8.	Crested Goshawk *Accipiter trivirgatus*	*				
9.	Chinese Goshawk *Accipiter soloensis*			*		
10.	Japanese Sparrowhawk *Accipiter gularis*	*	*	*		
11.	Grey-faced Buzzard *Butaster indicus*			*		
12.	Changeable Hawk-Eagle *Spizaetus cirrhatus*	*				
13.	Eastern Marsh Harrier *Circus aeroginosus*			*		
14.	Black-thighed Falconet *Microhierax fringillarius*	*				
15.	White-breasted Waterhen *Amaurornis phoenicurus*		*	*	*	
16.	Watercock *Gallicrex cinerea*		*			
17.	Grey Plover *Pluvialis squatarola*					*
18.	Pacific Golden Plover *Pluvialis fulva*					*
19.	Lesser Sand-Plover *Charadrius mongolus*					*
20.	Greater Sand-Plover *Charadrius leschenaulti*					*
21.	Eurasian Curlew *Numenius arquata*					*
22.	Whimbrel *Numenius phaeopus*					*
23.	Bar-tailed Godwit *Limosa lapponica*					*
24.	Common Snipe *Gallinago gallinago*			*		
25.	Common Redshank *Tringa totanus*					*
26.	Marsh Sandpiper *Tringa stagnatilis*					*
27.	Common Greenshank *Tringa nebularia*					*
28.	Wood Sandpiper *Tringa glareola*					*
29.	Terek Sandpiper *Xenus cinereus*					*
30.	Common Sandpiper *Actitis hypoleucos*		*			*

NO.	SPECIES	A	B	C	D	E
31.	*Red-necked Stint Calidris ruficollis*					*
32.	Curlew Sandpiper *Calidris ferruginea*					*
33.	White-winged Tern *Chlidonias leucopterus*					*
34.	Black-naped Tern *Sterna sumatrana*					*
35.	Gull-billed Tern *Gelochelidon nilotica*					*
36.	Little Tern *Sterna albifrons*					*
37.	Thick-billed Pigeon *Treron curvirostris*	*				
38.	Pink-necked Pigeon *Treron vernans*		*			
39.	Feral Pigeon *Columba livia*				*	
40.	Spotted Dove *Streptopelia chinensis*		*	*	*	
41.	Peaceful Dove *Geopelia striata*		*	*	*	
42.	Green-winged Pigeon *Chalcophaps indica*	*				
43.	Long-tailed Parakeet *Psittacula longicauda*	*	*	*		
44.	Blue-rumped Parrot *Psittinus cyanurus*	*				
45.	Blue-crowned Hanging Parrot *Lorriculus galgulus*	*				
46.	Plaintive Cuckoo *Cacomantis merulinus*	*				
47.	Drongo Cuckoo *Surniculus lugubris*	*				
48.	Black-bellied Malkoha *Phaenociphaeus diardi*	*				
49.	Chestnut-breasted Malkoha *Phaenicophaeus curvirostris*	*				
50.	Raffle's Malkoha *Phaenicophaeus chlorophaeus*	*				
51.	Greater Coucal *Centropus sinensis*		*	*		
52.	Lesser Coucal *Centropus bengalensis*		*	*		
53.	Barn Owl *Tyto alba*		*	*	*	
54.	White-vented Needletail *Hirundapus cochinchinensis*	*				
55.	Silver-rumped Swift *Rhapidura leucopygialis*	*				
56.	House Swift *Apus affinus*			*	*	
57.	Asian-palm Swift *Cypsiurus batasiensis*					*
58.	Grey-rumped Treeswift *Hemiprocne longipennis*		*	*		
59.	Whiskered Treeswift *Hemiprocne comata*	*				
60.	Common Kingfisher *Alcedo atthis*	*				*
61.	Stork-billed Kingfisher *Halcyon capensis*					*
62.	White-throated Kingfisher *Halcyon smyrnensis*	*	*	*	*	*

NO.	SPECIES	A	B	C	D	E
63.	Collared Kingfisher *Halcyon chloris*					*
64.	Blue-tailed Bee-eater *Merops philippinus*		*	*	*	*
65.	Dollarbird *Eurystomus orientalis*	*	*	*		
66.	Rhinoceros Hornbill *Buceros rhinoceros*	*				
67.	Gold-whiskered Barbet *Megalaima chrysopogon*	*				
68.	Red-crowned Barbet *Megalaima rafflesii*	*	*			
69.	Yellow-crowned Barbet *Megalaima henricii*	*				
70.	Blue-eared Barbet *Megalaima australis*	*				
71.	Crimson-winged Woodpecker *Picus puniceus*	*				
72.	Common Goldenback *Dinopium javanense*	*	*			
73.	Grey-and-Buff Woodpecker *Hemicircus concretus*	*				
74.	Barn Swallow *Hirundo rustica*	*	*	*	*	*
75.	Pacific Swallow *Hirundo tahitica*	*		*		
76.	Black-winged Flycatcher-shrike *Hemipus hirundinaceus*	*				
77.	Blue-winged Leafbird *Chloropsis cochinchinensis*	*				
78.	Yellow-vented Bulbul *Pycnonotus goaivier*	*	*	*	*	*
79.	Cream-vented Bulbul *Pycnonotus simplex*	*				
80.	Red-eyed Bulbul *Pycnonotus brunneus*	*				
81.	Buff-vented Bulbul *Hypsipetes charlottae*	*				
82.	Bronzed Drongo *Dicrurus aeneus*	*				
83.	Greater Racket-tailed Drongo *Dicrurus paradiseus*	*	*			
84.	Black-naped Oriole *Oriolus chinensis*	*	*		*	*
85.	House Crow *Corvus splendens*		*	*	*	*
86.	Large-billed Crow *Corvus macrorhynchos*	*	*			*
87.	Magpie Robin *Copsychus saularis*	*	*	*	*	*
88.	Flyeater *Gerygone sulphurea*	*	*			*
89.	Dark-necked Tailorbird *Orthotomus atrogularis*	*				
90.	Ashy Tailorbird *Orthotomus sepium*	*	*			*
91.	Rufescent Prinia *Prinia rufescens*	*				
92.	Yellow-bellied Prinia *Prinia flaviventris*		*	*		
93.	Zitting Cisticola *Cisticola juncidis*			*		
94.	Pied Fantail *Rhipidura javanica*	*	*			*

NO.	SPECIES	A	B	C	D	E
95.	Yellow Wagtail *Motacilla flava*			*		*
96.	Richard's Pipit *Anthus novaeseelandiae*			*		
97.	Brown Shrike *Lanius cristatus*	*	*	*	*	*
98.	**Philippine Glossy Starling** *Aplonis panayensis*	*	*	*	*	*
99.	Common Myna *Acridotheres tristis*		*	*	*	*
100.	Jungle Myna *Acridotheres fuscus*	*	*	*	*	*
101.	Hill Myna *Gracula religiosa*	*				
102.	Olive-backed Sunbird *Nectarinia jugularis*	*				*
103.	Little Spiderhunter *Arachnothera longirostra*	*				
104.	Orange-bellied Flowerpecker *Dicaeum trigonostigma*	*				
105.	Eurasian Tree-sparrow *Passer montanus*		*	*	*	
106.	Baya Weaver *Ploceus philippinus*			*		
107.	White-rumped Munia *Lonchura striata*		*	*		
108.	Scaly-breasted Munia *Lonchura punctulata*			*		
109.	Chestnut Munia *Lonchura malacca*			*		
	TOTAL	57	38	39	21	44

Habitat Types

A - *Peat Swamp Forest*
B - *Estate Cultivation (Rubber & Oil Palm)*
C - *Open Scrubland (including Cash Cropping)*
D - *Urban Areas*
E - *Coastal habitat (Mangroves & Mudflats)*

- *Total Number of Species recorded was 109.*
- *Migrant species are shaded.*
- *Species with the potential to cause a bird hazard are in bold.*
- *Surveys were conducted during period August - October 1992.*